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MANAGEMENT DECISION SYSTEMS: A FRAMEWORK FOR MANAGEMENT INFORMATION SYSTEMS

by

G. Anthony Gorry and Michael S. S. Morton

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There have been many references in the literature to the fact that the number of computers installed in the U.S. has grown from fewer than 100 in 1955 to more than 60,000 in 1970. During this time, there also has been a marked growth in computer-related activities collectively termed 'Management Information Systems'. Unfortunately, in spite of the growth in these two areas, very few of the resulting systems have had a significant impact on management, that is on the way in which they make decisions and on the kinds of decisions which they make. We believe that this failure can be traced in large part to a lack of a proper perspective concerning the problems involved in augmenting the decision making ability of management. Our purpose in this paper is to outline the concept of the Management Decision System from which the required perspective can be obtained.

This lack of perspective in many groups doing MIS work results from a failure to fully appreciate the range of uses of computers in organizations. Without some framework to guide the management and the system plannners, there is a real tendency to serve the strongest manager or the greatest crisis. Over time, systems activities move from crisis to crisis, following no clear path and receiving only ex post facto justification.

This tendency is unfortunate because it results in a significant expense to the organization. The computer resources consumed are costly, but the costs in human terms and in terms of lost opportunities are even

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greater. The cost of systems and programming personnel is generally twice that of the hardware involved in a system, and the ratio is growing larger as the cost of hardware drops and salaries rise. Not only are competent people expensive, but their limited numbers in a given organization serves as an active constraint on the amount of systems development work that can be undertaken. Therefore, careful attention must be paid to maintaining a proper perspective so that lost opportunities are kept to a minimum.

Developments in two distinct areas within the last five years have made it particularly appropriate that we should re-assess the framework within which we view the allocation of resources to systems activities. We now have the potential to develop altogether new ways of supporting decision processes.

First, there has been considerable technological progress. The evolution of remote access to computer power with short turn around time opens a new set of possibilities in the area of information and decision systems. This evolution has resulted in a variety of specific systems, with direct and flexible user access as the common theme. In addition, low cost typewriter and graphical display terminals have been developed through which users are linked to the resources of the computer system.

The second development in the last few years has been a conceptual one. An understanding of the inherent structure of information systems within organizations is emerging. In addition, we are adding to our knowledge of the ways in which human beings solve problems and of ways

in which we can build models that capture aspects of their decision making processes. These insights provide us with some important concepts for systems design. Our experience in dealing with the problems of system implementation has helped to realize general relevance of these concepts to a range of information systems.

The progress in these areas has been dramatic, and our planning and control systems should reflect the new capabilities. We now can build entirely new kinds of systems, ones that dynamically involve the manager's judgment and support him with analysis, models, and flexible access to relevant information. In order to fully realize this potential, however, we must have an appropriate framework within which to view management decision making and systems support. Our purpose here is to present such a framework, one that elucidates the differences between the traditional MIS approach and that embodied in the emerging concept of Management Decision Systems.

Framework Development

Robert Anthony in his book Planning and Control Systems: A Framework for Analysis addresses the problems of developing a "framework" that will allow management some perspective when dealing with planning and control systems. He develops a taxonomy for managerial activities consisting of three categories. He argues that these categories represent activities which are sufficiently different in kind to require the development of different systems.

One category of managerial activity which Anthony proposes is Strategic Planning which he defines as follows:

> Strategic planning is the process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use, and disposition of these resources.[1]

Strategic planning, then, is focused on the choice of objectives for the organization and on the planning required to achieve these objectives. As a result, a major activity in this area is the development of predictions about the future of the organization and its environment. The strategic planning process typically involves a fairly small number of people, but it is difficult to make an appraisal of the quality of this planning process.

The second category defined by Anthony is that of Managerial Control:

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[1]Robert Anthony, Planning and Control Systems: A Framework for Analysis, Graduate School of Business Administration, Harvard University, Boston, 1965, p. 16.

> Management Control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives.[2]

He stresses three key aspects of this area. First the activity involves interpersonnal interaction. Second it takes place within the context of the policies and objectives developed in the strategic planning process, and thirdly, the paramount goal of the management control activity is the assurance of effective and efficient performance.

The third area which Anthony discusses is Operational Control, by which he means: "The process of assuring that specific tasks are carried out effectively and efficiently".[3] He distinguishes Operational Control from Management Control in two important ways: 1) Operational Control is generally concerned with tasks (such as manufacturing a specific part), whereas Management Control is most often concerned with people; 2) there is less judgment to be exercised in the Operational Control area, because the tasks, goals, and resources have been carefully delineated through the management control activity. The constraints on the exercise of managerial judgment are less stringent in the Management Control area.

Anthony makes it very clear that he feels that there are no clear boundaries for these categories, and he discusses at length the distinctions which he would draw when thinking of these categories in the context of planning and control systems. Our emphasis here is on the information

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[2] Ibid., p. 17.

[3] Ibid., p. 18.

requirements of management, and although these three categories are not completely satisfactory, they do provide a basis for an initial consideration of these needs.

From Figure 1, it should be clear that the information requirements of the operational control area are very different from those of the strategic planning area. This difference is not simply a matter of aggregation, but in the fundamental character of the information needed by managers in these areas.

This suggests that the once popular "total systems" approach, depicted in Figure 2, incorporates a potentially fatal misconception. To the extent that the proponents of this approach are advocating: 1) that systems throughout the organization should be tightly linked with the output of one becoming the direct input to another, and 2) that the whole structure be built on the detailed data used for controlling operations, they are suggesting an approach to systems design which is at best uneconomic.

The first major problem with this view is that it does not give proper recognition to the ongoing nature of systems development in the operational control area. There is little reason to believe that this systems work in any major organization will be 'complete' within the foreseeable future. To say that management information systems activity must wait 'until we get our operational control systems in hand' is to say that efforts to assist management with systems support will be deferred indefinitely.

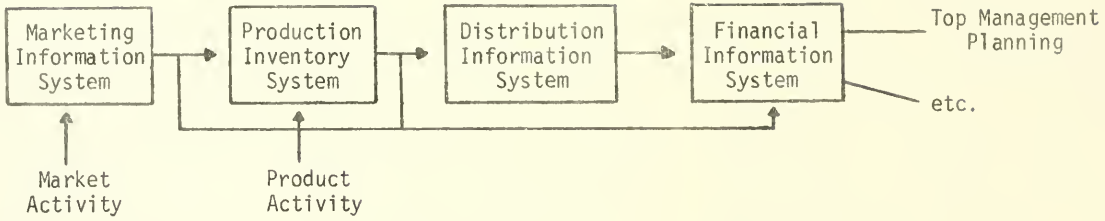
FIGURE 1

Information Characteristics by Decision Category

Characteristics of Information	Operational Control	Management Control	Strategic Planning
Source	Largely internal. . . . . →		External
Scope	Well defined, narrow. . . . . →		Very wide
Level of Aggregation	Detailed. . . . . →		Aggregate
Time Horizon	Historical. . . . . →		Future
Currency of Data-Base	Highly current. . . . . →		Quite old
Units	Largely others. . . . . → (rate, # pieces, quality)		$ and others
Required Accuracy	High. . . . . →		Low
Frequency of Occurrence of Information Change	High. . . . . →		Low
Frequency of Use of Information	Very frequent . . . . . →		Infrequent

FIGURE 2

Typical "Total" System Representation



Perhaps the most serious problem with this total systems view is that it fails to properly represent the information needs of the Management Control and Strategic Planning areas. Neither of these areas necessarily needs information that is a mere aggregation of data from the Operational Control data base. In many cases, if such a link is needed, it is more cost-effective to use sampling and other statistical techniques to develop the required information. Seldom, if ever, does it make sense to directly couple managers in the Management Control and Strategic Planning areas to the masses of detailed data required for Operational Control. We will return later in this paper to the implications of this for systems design.

It is important to note that neither Anthony's categories nor our interpretation of them involve any necessary correlation with organizational level. Managers at the very highest level are often involved in Operational Control activities; perhaps often too much so. It is reasonable, for example, for the Treasurer of an organization to make the decision about the disposition of excess cash over the weekend. This is an ongoing Operational Control decision, but one that is often made very high in the organization.

Anthony classifies managerial activity from the viewpoint of planning and control. Another approach is to focus on the types of problems faced by individuals. This latter approach is one taken by H. A. Simon in his general discussion of human problem solving. His distinction between "programmed" and "nonprogrammed" decisions is a

useful one. He regards them as being at opposite ends of a continuum, and he is careful to assert that they are not sharply-defined categories. Simon describes these as follows:[4]

> 1. Decisions are programmed to the extent that they are repetitive and routine, to the extent that a definite procedure has been worked out for handling them so that they don't have to be treated de novo each time they occur.
>
> 2. Decisions are nonprogrammed to the extent that they are novel, unstructured, and consequential. There is no cut-and-dried method for handling the problem because it hasn't arisen before, or because its precise nature and structure are elusive or complex, or because it is so important that it deserves a custom-tailored treatment.
>
> By nonprogrammed I mean a response where the system has no specific procedures to deal with situations like the one at hand, but must fall back on whatever general capacity it has for intelligent, adaptive, problem-oriented action.

We prefer the terms "structured" and "unstructured" to "programmed" and "non-programmed" because they imply less dependence on the computer and more on the basic character of the problems.

The importance of distinguishing between these two types of problems is because our approach to problem solving differs for the two. Different procedures, different kinds of computation, and different types of information may be required depending on the extent to which the problem in question is unstructured. This is basically because in the latter case

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[4] H. A. Simon, The New Science of Management Decision, Harper and Rowe, 1960, p. 6.

the human decision maker plays such a vital role in providing judgment and evaluative capacity as well as insights into problem definition. Such a situation is fundamentally different from that associated with problem solving for very structured problems where much, if not all, of the decision making process can be automated. Generally speaking, then, systems built to support structured decision making will be significantly different from those designed to augment the capacity of managers to deal with unstructured problems.

Development of the Management Decision Systems Framework

We suggest that more can be gained from these two viewpoints in combination than from either alone as far as MIS perspective is concerned. Figure 3 presents one synthesis of these ideas. There are two interesting features of this categorization. The first is that almost all "MIS" activity so far has taken place in the "structured" half of the matrix and within this in the Operational Control area. Only a few working systems to date are in the structured Management Control or Strategic Planning area -- all the rest fall into the structured Operational Control.

Some examples of each of these areas are:

a) Structured/Operational Control

Inventory control - reorder systems

Income statement generation

b) Unstructured/Operational Control

Short term cash management

Job shop scheduling

c) Structured/Management Control

Variance Analysis for engineered costs

Budget comparisons

Development of short term forecasts

d) Unstructured/Management Control

Development of initial budget levels

Sales strategy planning

Production planning

FIGURE 3

Information Systems Framework

Examples:

	OPERATIONAL CONTROL	MANAGEMENT CONTROL	STRATEGIC PLANNING
STRUCTURED	Accounts Receivable Inventory Control Income Statements etc.	Variance Analysis Forecasting Short Term etc.	LP Models - Tanker Fleet Factory Location etc.
UNSTRUCTURED	Short Term Cash Mgt. Job-Shop Scheduling Advertising Selection etc.	Budget Preparation Sales Planning Production Planning etc.	New Product Planning Mergers & Acquisitions etc.

e) Structured/Strategic Planning

Linear programming models for tanker fleet strategy

Simulation models for warehouse location

f) Unstructured/Strategic Planning

New product planning

Mergers and acquisitions

We feel that these are viable categories which enhance our ability to discriminate among various types of management activity.

As is obvious from this rough categorization, most of the interesting areas that really concern managers, areas where decisions have a significant effect on a company, are in the lower half of the diagram. That is, managers of stature deal with unstructured decisions, if not most of their working time certainly for most of their significant decisions.

This implies of course that computers and related systems which have so far been largely applied to the structured area have not yet had any impact on management decision making -- and that the areas of high potential do not lie in bigger and better systems of the kind most companies now have. Most of the opportunities for improving the "effectiveness" as opposed to the "efficiency" of an operation lie below the line separating structured from unstructured.

The shifting characteristics of this dividing line is also extremely important for our later arguments. Over time this line is moving downward producing a larger and larger set of decisions which we can call structured. A simple example should make this clear.

Clarkson[5] built a model to simulate the decision processes of a trust investment officer. He took protocols, built decision rules, and tested his model on actual portfolio selection problems. Basically he found that the decisions from the model matched those of the trust officer. Although this experiment was a relatively simple one, it did show that certain aspects of a decision process which had formerly been thought to be quite complex could be structured. The structuring of decision processes has become increasingly common in recent years.

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[5] G. P. E. Clarkson, "A Model of the Trust Investment Process," in Computers and Thought, E. A. Feigenbaum and J. Feldman (Editors), McGraw-Hill, 1963.

A Comment on Current MIS Activities

Management Information Systems to this point have not had much in the way of a unifying theme. There has been no common definition and very little attempt at overview and generalization. A great many writers and many systems designers seem to think in terms of an operational, physical, process view of the organization, or of a functional view of the information system, that of marketing, production, finance.

Our view of systems to support decisions and processes in the structured area is shown schematically in Figure 4.[6] From this it can be seen that information systems exist to support the planning and control system in an organization. This is, of course, an obvious point, but all too often the MIS project becomes an end in itself and no attempt is made to go through the analysis implied in the diagram. Clearly at any given level in an organization it is important to identify objectives. From these a set of relevant key variables can be constructed, a set of measures that reflect the objectives. These will be partly determined by the organizational structure in effect at any one moment, and by the environmental forces at work. From this base it is possible to construct a management planning and control system to monitor these key variables. For structured problems this planning and control system will not change rapidly and is known in advance -- hence we can build an information system based on traditional technology.

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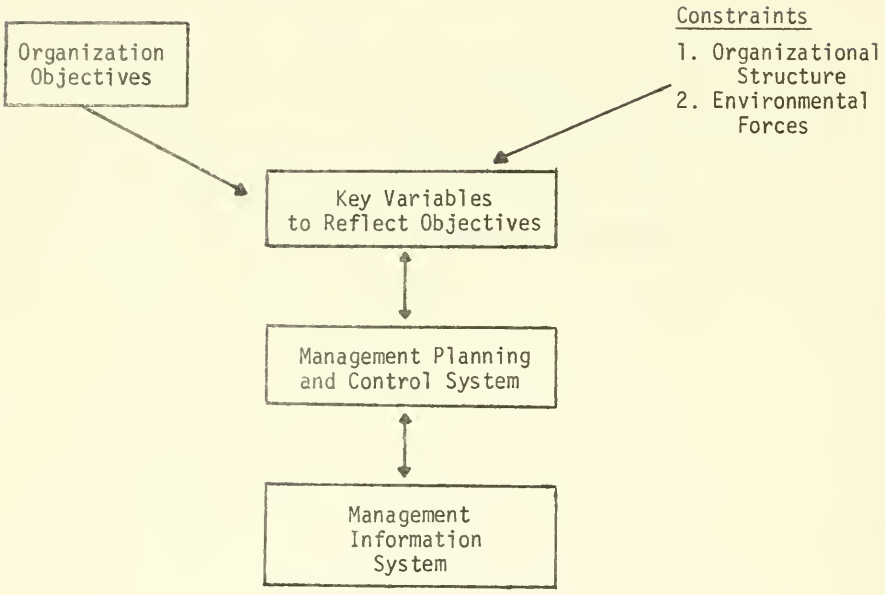
[6]This is based on Anthony's use of a similar scheme in his analysis of control systems.

FIGURE 4

Information Systems for Structured Problems



This approach is adequate to the extent that we are dealing with structured problems. The MDS point of view is to look at the organization in terms of decisions that must be made. Such a "decision-centered" point of view makes it easy to isolate the key decisions of key managers and to focus the systems effort where it will have high payoff. The benefit to be gained from in-depth analysis of a given decision is very great, irrespective of the nature of the final support for that decision. This decision-centered point of departure for analysis and systems design has the merit of focusing directly on the user and his needs. In many cases such analysis will result in an interactive man/machine system -- in others the traditional batch system can provide the support necessary.

A View of Decision-Making

This focus on decisions requires that we understand the human decision-making process. Research work on the subject of human problem solving has tended to support Simon's claim that all problem solving can be broken down into three categories:[7]

1. The first phase of the decision-making process -- searching the environment for conditions calling for decision -- I shall call intelligence activity (borrowing the military meaning of intelligence). The second phase -- inventing, developing, and analysing possible courses of action -- I shall call design activity. The third phase -- selecting a particular course of action from those available -- I shall call choice activity.

2. Generally speaking, intelligence activity precedes design, and design activity precedes choice. The cycle of phases is, however, far more complex than this sequence suggests. Each phase in making a particular decision is itself a complex decision-making process. The design phase, for example, may call for new intelligence activities; problems at any given level generate subproblems that, in turn, have their intelligence, design, and choice phases, and so on. There are wheels within wheels within wheels. Nevertheless, the three large phases are often clearly discernible as the organizational decision process unfolds. They are closely related to the stages in problem solving first described by John Dewey:

   What is the problem?
   What are the alternatives?
   Which alternative is best?[8]

Simon makes the point clearly above that this problem solving process is a highly iterative hierarchical process. For example, the Intelligence

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[7]Simon, op. cit., p. 4.

[8]John Dewey, How We Think, Chapter 8, D. C. Heath & Company, New York, 1910.

phase could be thought of as a sub-problem which in order to "find" a problem requires the user to go through the Intelligence, Design and Choice at a level one lower than the initial problem statement. This iterative, hierarchical characteristic is hard to represent on paper, but it should be kept clearly in mind during the subsequent discussion.

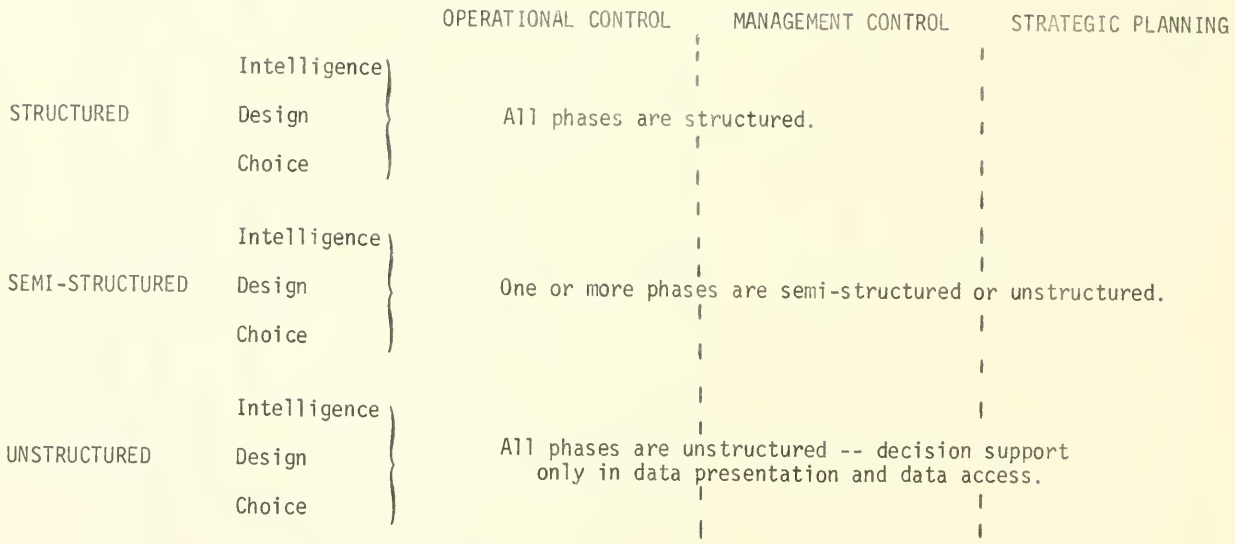
Taking Simon's finder breakdown we can augment the diagram to create Figure 5. This breakdown is useful as it allows us to be somewhat more specific about the structured and unstructured problem types.

A fully structured problem is one in which all three phases of Intelligence, Design and Choice are structured. That is, we can specify algorithms or decision rules that will allow us to find the problem, design a solution and select the best solution. An example here might be the inventory control problem in a simple case -- one where demand was known with a high degree of accuracy and replenishment times were very predictable with all costs known reasonably accurately. In such a case we can set up criteria which tell us when there is a problem (the reorder point is broken). Given this condition the solution generation process takes a known model, the re-order quantity formula, plugs in the latest numbers and generates an answer which in this case is chosen automatically.

Similarly, in a semi-structured area we can find problems where the search for a problem is difficult -- although the design and choice of a solution is of little difficulty. In such a case we might want to design flexible man/machine interaction on the search activity but leave the design and choice to the system. Other examples can be given where one or

FIGURE 5

Management Decision Systems Framework



more of the other phases is unstructured. With all three unstructured then of course we are in the fully unstructured state, where all we can do is provide access to the data and useful ways of displaying it.

This clarification of the semi-structured area is important because it lets us see how we can move problems out of the unstructured area into the structured. For example in Clarkson's case, he structured the Intelligence part quite well but did very little to the Design and Choice phases. If the Bank had recognized this system as support for problem finding they might have been able to usefully incorporate it into their ongoing system.

Through the development of a model of a given problem solving process, we can establish the character of each of the three phases. To the extent that any of these phases can be structured, we can design direct systems support. For those aspects of the process that are unstructured (given our current understanding of the situation), we would call on the manager to provide the necessary analysis. Thus a problem might be broken down into a set of related subproblems, some of which are 'solved' automatically by the system and the remainder are dealt with by the user alone or with varying degrees of computational and display support. Regardless of the resulting division of labor, however, it is essential that a model of the decision process be constructed prior to the system design. It is only in this way that a good perspective on the potential application of systems support can be ascertained. This is a fundamental tenet of the MDS approach.

Implications of the MDS Approach

We recognize that functional breakdowns in information systems work were intended in part to provide a measure of generality. That is, a marketing information system could take care of any reasonable request for raw data to support any marketing decision. Without the analysis of the decisions which are made, and the process by which these decisions are reached, however, much of the necessary data manipulation and processing must be performed by the manager or his staff. In addition to depriving the decision maker of potentially powerful systems support, the lack of analysis often prevents the organization from externalizing vital decision processes. This then continues the process by which organizations rely on the "wisdom", "judgment" and "intuition" of their managers. While all these characteristics will continue to be important for good management, there is in every decision some structure which the manager uses -- he does after all make a decision. By externalizing as much as possible the decision maker can teach others the process he goes through, he can learn himself from his own decisions and the organization has itself learned. This learning will form a basis on which future progress can be based.

The MDS approach advocates a focus on a particular decision process, and because there are very many important decisions made in a given organization, and many of these are made only at irregular intervals, we are faced with a potentially large systems design and implementation cost.

Our response to this problem is at two levels. First, we expect any proposal for systems development to survive a cost/benefit analysis. In terms of the MDS approach, on the benefit side, we would consider the improvement in the quality of decisions (whether they are made by the system or by the manager with new systems support) and try to relate this improvement to some form of payoff measure. Under such an analysis, decisions with low resource implications should never become serious candidates for systems activities. Following the MDS approach, the focus of systems development is on the key decisions of the organizations.

At the same time, we do not want to minimize the difficulties in doing a cost/benefit analysis for a system intended to improve the quality of decision making within the organization. The assessment of the benefits of such a system is far more difficult than that for a system designed to achieve clerical savings through the automation of an existing organizational procedure. These problems of assessing benefit and cost for systems to support top management decision making have received insufficient attention to date. The result has been a decided lack of rationality in the way in which many organizations have approached the problem of allocating resources to systems development. Although the importance of this problem is increasing we will not discuss it in detail here. It should be noted, however, that this problem is by no means unique to the MDS approach.

Our second response to the potential proliferation of decisions to be considered in the MDS approach is related to the generality of the processes involved. It may be that the Intelligence activity involves

many of the same processes regardless of whether it is intelligence in operational control, management control, or strategic planning. To the extent that such commonality exists, we can construct support packages that can be used in many different applications with many different decision makers. For example, in Intelligence one would need the ability to scan data sets, browse through data bases, apply pattern presentation and recognition methods, and so forth. The Design phase would require an ability to build models or test the structure of existing ones. Such access to a model bank could be under system control or entirely in the hands of the user. The Choice phase requires an ability to specify criteria and to test possible solutions against them. This again requires a strong evaluative capability as well as considerable flexibility in criteria specification.

The MDS framework enables us to make some further general observations about the current state of MIS work, and offers new insights which could change the direction of work in this area. Hopefully these observations will prompt discussions of the role of information systems in the augmentation of the decision making capacity of the organization.

The principal focus of the MDS approach is on the important decisions of the organization. The realization of this focus should be the development of a model of the decision process that is involved. This model development is fundamental, because it is a prerequisite for the analysis of the value of information, and it is the key to the understanding of the

portions of the decision process that can be supported or automated. Both the successes and failures of the MIS work to date can be understood largely in terms of the difficulty of this model development.

Our discussion of MIS work showed that the vast majority of the effort (and success) has been in the area of structured operational control area. The fact that this area is structured implies that there exist definite, routine procedures for dealing with problems. Secondly, in the operational control area, there is relatively little ambiguity as to the goals sought. For example, the typical inventory control problem can be precisely stated, and it is clear what the criterion is by which solutions are to be judged. Hence we have a well understood optimization problem. This type of problem lends itself to the development of formal, "scientific" models, those typical of operations research.

Another important characteristic of problems of this type is that they are to a large extent "organization-independent". By this we mean that the essential aspects of the problem tend to be the same in many organizations, although details may differ. The generality of the problem has two important effects. First it encourages widespread interest and effort in the development of solutions to the problem. Second, it makes the adaptation of general models to the situation in a particular organizational setting relatively easy.

The situation with regard to the other areas of management decision making is quite different. To the extent to which a given problem is semi-structured or unstructured, there is an absence of a routine procedure

for dealing with it. Also there is a tendency for there to be some ambiguity in the problem definition. This is because a lack of formalization of any or all of the Intelligence, Design, or Choice phases of the decision making process. Confusion may exist as to the appropriate criterion for evaluating solutions, or as to the means for generating trial solutions, to the problem. In many cases, this uncertainty contributes to the perception of problems of this type as being unique to a given organization.

In general, then, we can say that the MIS problem in the structured operational control area is basically that of implementing a given general model in a certain organizational context. On the other hand, work in the unstructured areas is much more involved with model development and formalization. Furthermore, the source of the models in the former case is apt to be the operations research or management science literature. In the latter case, however, the relevant models are most often the as yet unverbalized models used by the managers of the organization. This suggests that the procedure for the development of systems, the types of systems, and the skills of the analysts involved may be quite different in the two areas.

First consider the people involved in the systems development work. The evolution of information systems activities in most organizations has led to the accumulation of a variety of technical skills. In many cases, the collective knowledge of computers and telecommunications is impressive.

In many of these same organizations, however, the impact of computers on the way in which top managers make decisions has been minimal. The reason for this is that the support of these decision makers is not principally a technical problem. If it were, it would have been solved. Certainly there are technical problems associated with work in these problem areas, but the technology and the technological skills in most large organizations are more than sufficient. This missing ingredient is the skill to elicit from management their view of their organization and its environment and to formalize models of this view.

Unfortunately, success in operational control applications is no guarantee of success in the unstructured problem areas. We have discussed the fundamental differences in the two types of problems in order to underscore this point. In many cases, the view taken by systems people experienced in the operational control areas is at best inappropriate for MDS work.

Consider an extremely elementary view of a decision process. The picture is of a 'black box' with information as inputs and decisions as outputs. The aim of a systems designer should be to improve the quality of the decisions which are produced by the process. Basically this can be done in two ways. Either the quality of the information inputs can be improved (assuming that the actual decision process remains unchanged), or the decision process can be altered (given the same information inputs). Of course, there is always the possibility of changing both aspects at the same time.

Because of the existence of a variety of optimization models for operational control problems, there is a tendency for less emphasis to be placed on the decision process in this area. In many cases, systems designers know how to make optimal decisions (e.g., inventory control) or at least very good decisions (e.g., production scheduling). The emphasis in this area is on the improvement of the information inputs to the decision model. Hence the importance of real time systems and telecommunications and the like is great.

Although this emphasis on the quality of information inputs is appropriate for structured operational control problems, it can retard progress in developing support for unstructured problem solving. The difficulty with this view is that it tends to attribute low quality in management decision making to low quality information inputs. Hence, systems are designed to supply more current, more accurate, or more detailed information. In the extreme, managers are inundated with such information.

While improving the quality of information available to managers may improve the quality of their decisions, we do not believe that major advances will be realized in this way. This is because we believe that most managers do not have great informational needs, but rather they have need for new methods to understand and process the information already available to them. Generally speaking, the models that they employ in dealing with this information are very primitive, and as a result, the range of responses that they can generate is very limited. For example, many managers employ simple historical models in their attempts to

anticipate the future. Further, these models are static in nature, although the processes they purport to represent are highly dynamic. In such a situation, there is much more to be gained by improving the information processing ability of managers in order that they may effectively deal with the information that they already have, than in adding to the reams of data confronting them, or in improving the quality of that data.

If this view is correct, it suggests that the application of the MDS approach is important, and it may best be realized by people other than those currently involved in the operational control systems area. The requisite skills are those of model building based on close interactions with management; structuring and formalizing the procedures employed by managers; and segregating those aspects of the decision process that can be automated. In addition, the MDS approach recognizes the importance of assisting the evolution of the manager's ability to deal with the problems confronting him through increasing his understanding of the environment. Hence, one important role of an MDS is educative. Even in areas in which we cannot structure the decision process, we can provide models of the environment from which the manager can develop insights into the relationship of his decisions to the goals he wishes to achieve.

In discussing models and their importance to the MDS approach, we should place special emphasis on the role which the manager assumes in the process of model building. To a large extent, he is the source upon

which the analyst draws. That is, although a repetoire of "operations research" models may be very valuable for the analyst, his task is not to simply impose such a model on the situation. These models may be the building blocks. The analyst and the manager in concert develop the final structure. This implies that the analyst must possess a certain empathy for the manager and vice versa. Whether the current systems designers in a given organization possess this quality is a question worthy of consideration by management.

Notice that the MDS approach in no way precludes normative statements about decision procedures. The emphasis on the development of descriptive models of managerial problem solving is only to ensure that the existing situation is well understood by both the analyst and the manager. Once this understanding has been attained, various approaches to improving the process can be explored. In fact, one of the chief benefits of the development of descriptive models of this type is that it exposes management decision procedures so that they may be analyzed. Hopefully, this analysis will lead to improvements in these processes.

Conclusions

Work must obviously continue on the structured area, indeed with our frequent focus on the information system as an end in itself we clearly have a long way to go. Such systems can have high payoff. For many organizations, however, these basic systems are moving toward the point of diminishing returns. The tendency, however, is to continue with

bigger, more elaborate versions of previous systems. This suits the character and knowledge of the overworked, hard-pressed computer and systems people.

We are suggesting that this incremental elaboration and extension of old systems will not increase the effectiveness of the organization. To do this one has to tackle the unstructured problems. The technology and concepts are available and have been successfully implemented in several settings.[9] It is clearly feasible. Focus on support for key decisions of key managers can bring about a significant change in the decision process.

Above all we are arguing that each company, and all those within it who deal with computers in any way, should have a clear framework in mind in which he can map his company's MIS efforts. Perspective is crucial in this fast changing field and it is worth the investment to build a framework that permits this.

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[9]For example, G. A. Gorry, "Sequential Diagnosis by Computer" (with G. O. Barnett), Journal of the American Medical Association, Vol. 205, September 16, 1968, pp. 849-854; M. S. S. Morton, "The Impact of Interactive Visual Display Systems on the Management Planning Process" (with James Stephens), Proceedings of the IFIP Congress 68, Edinburgh, Scotland, August 1968; and T. P. Gerrity, The Design of Man-Machine Decision Systems, Unpublished Ph.D. Dissertation, M.I.T. Sloan School of Management, June, 1970.

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